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(54) **CONTROLLED-RADIATION ANTENNA SYSTEM**

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See application file for complete search history.

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(57) **ABSTRACT**

The present description concerns an antenna system comprising a transmitting or receiving antenna element (**12**), an array of parasitic antenna elements (**14**), individually associated with reconfigurable loads (**15**), one or a plurality of near-field antennas (**32**), and a circuit (**18**, **34**) for setting the configuration of the array of parasitic antenna elements according to a radiation picked up by the near-field antenna (s) during a radio frequency transmission by the transmitting or receiving antenna element.

8 Claims, 4 Drawing Sheets

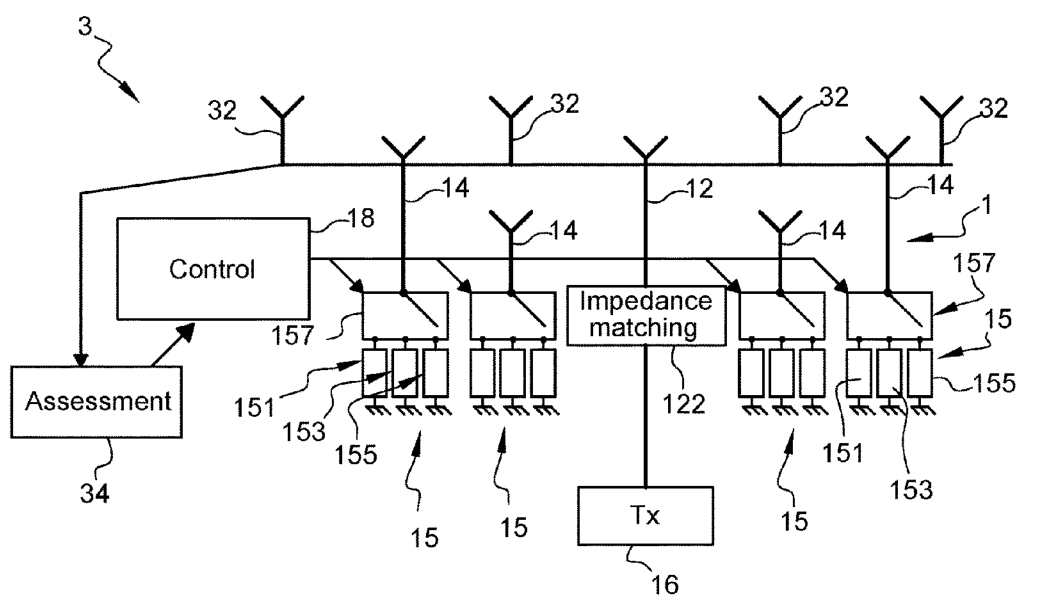

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Fig. 1

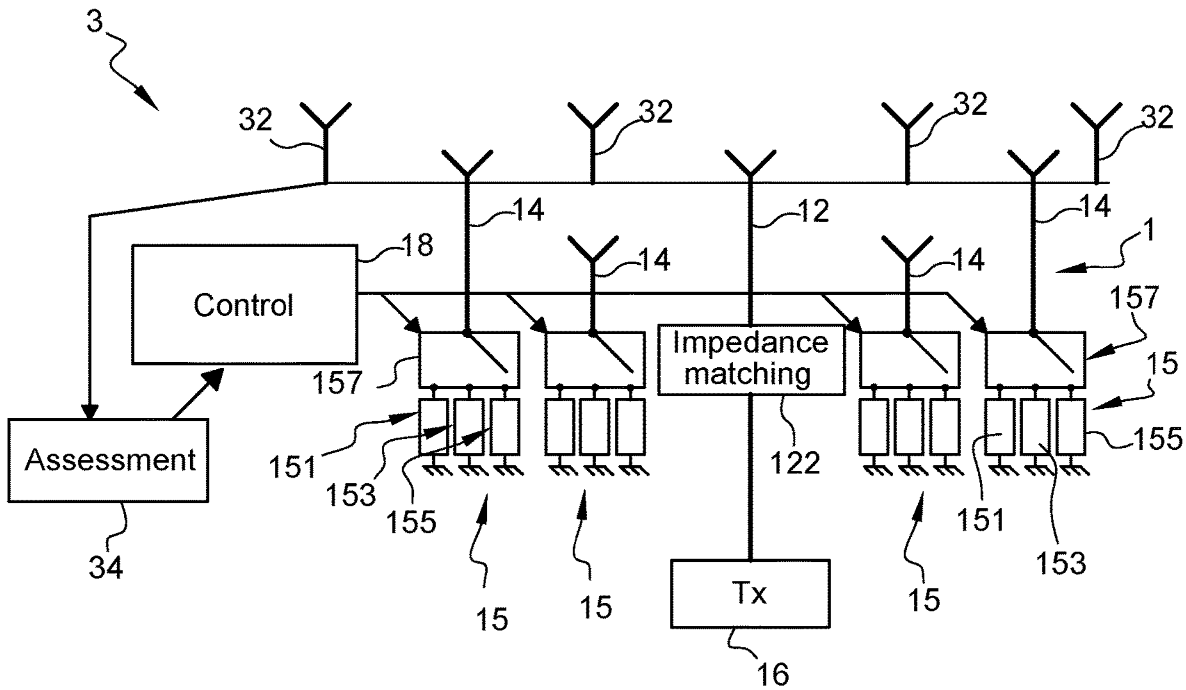

3
32
14
12
1
18
Control
157
Impedance matching
15
155
151
153
122
Assessment
34
Tx
16

Fig. 2

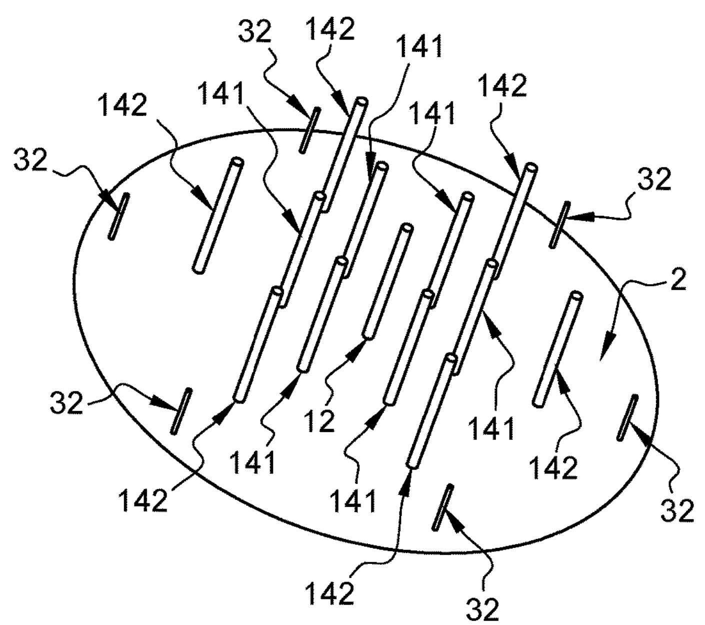
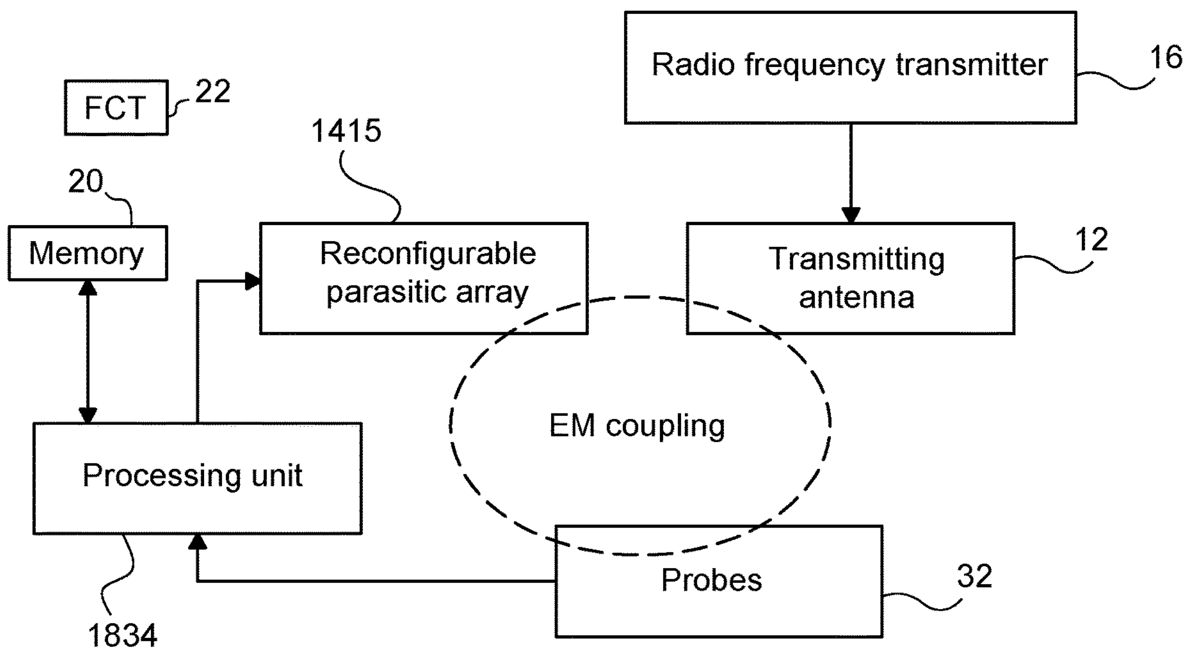

32
142
141
2
12

Fig. 3



Radio frequency transmitter
16
FCT
22
1415
20
Memory
Reconfigurable parasitic array
Transmitting antenna
12
EM coupling
Processing unit
Probes
32
1834

Fig. 4

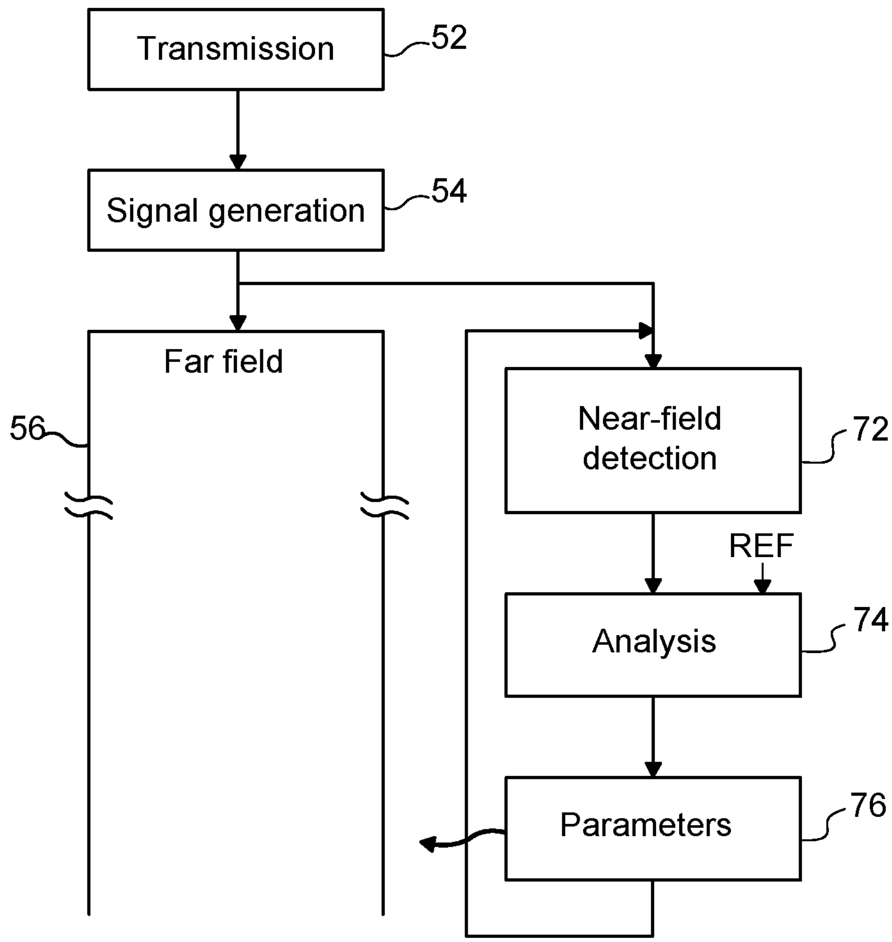

Transmission
52
Signal generation
54
Far field
56
Near-field detection
72
REF
Analysis
74
Parameters
76

Fig. 5

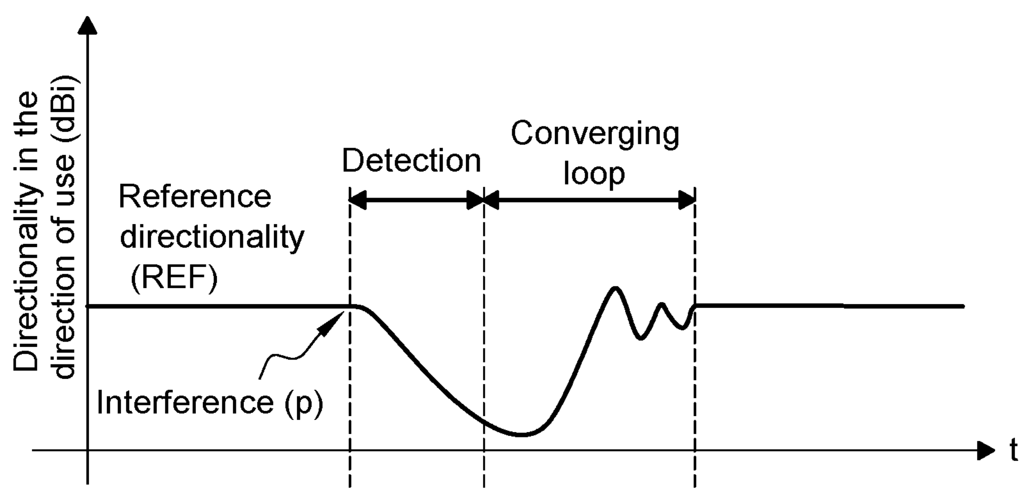

Directionality in the direction of use (dBi)
Reference directionality (REF)
Detection
Converging loop
Interference (p)
t

Fig. 6

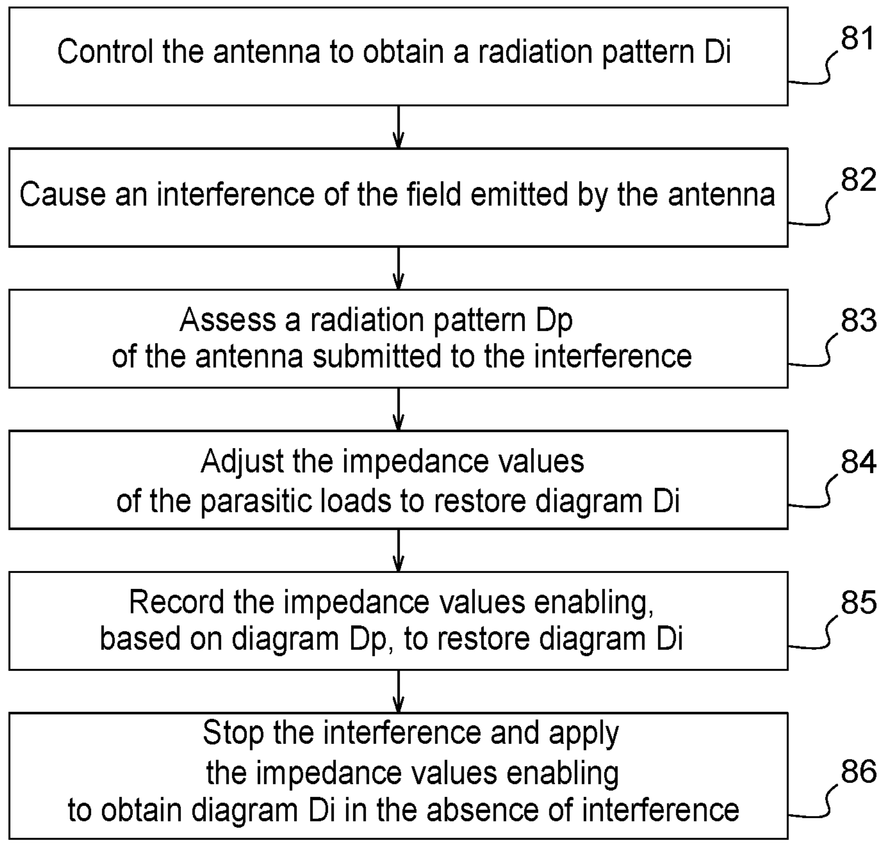
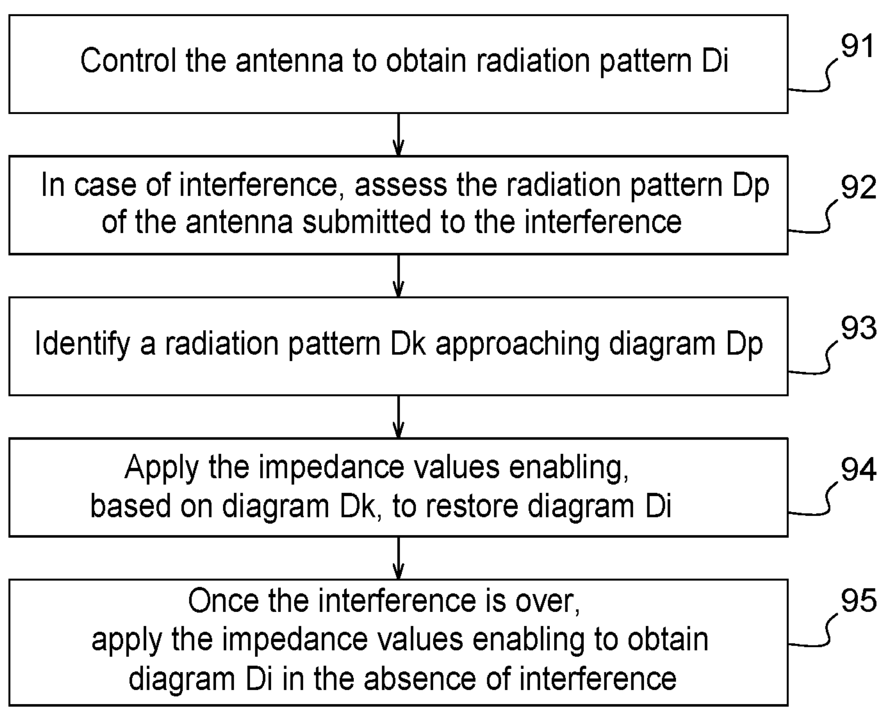

Control the antenna to obtain a radiation pattern Di
81
Cause an interference of the field emitted by the antenna
82
Assess a radiation pattern Dp of the antenna submitted to the interference
83
Adjust the impedance values of the parasitic loads to restore diagram Di
84
Record the impedance values enabling, based on diagram Dp, to restore diagram Di
85
Stop the interference and apply the impedance values enabling to obtain diagram Di in the absence of interference
86

Fig. 7


Control the antenna to obtain radiation pattern Di
91
In case of interference, assess the radiation pattern Dp of the antenna submitted to the interference
92
Identify a radiation pattern Dk approaching diagram Dp
93
Apply the impedance values enabling, based on diagram Dk, to restore diagram Di
94
Once the interference is over, apply the impedance values enabling to obtain diagram Di in the absence of interference
95

CONTROLLED-RADIATION ANTENNA SYSTEM

FIELD

The present disclosure generally concerns antenna arrays and more particularly compact and directional antennas. The present disclosure more particularly applies to reconfigurable antenna arrays.

BACKGROUND

Antenna arrays are widely used in radio frequency detection or transmission systems, particularly in telecommunication systems.

Antennas called directional or super directional are based on an array of antenna elements. They are generally formed from an array of antenna elements where the antennas are weighted and configured to focus the beam in a given direction. This may be implemented in the form of an architecture with parasitic elements (a single antenna, excited by a generator, which is coupled to one or a plurality of antennas called parasitic, coupled to a given load condition) or of an architecture based on the control of the amplitude and the phase associated with each element of the antenna array. Antenna architectures with parasitic elements use the couplings and interferences between the different antenna elements to set the radiation pattern of the antenna with a main lobe (useful) in a given direction (unidirectional antenna) and having a given angular width, or a plurality of useful lobes in different directions (multidirectional antenna).

Such antennas are particularly sensitive to their environment, which is likely to generate distortions in the radiation pattern of the antenna. This problem is all the more critical as the antenna has a small electric size (physical size to the wavelength). Further, the smaller the antenna, the more sensitive it is to interferences of its close environment. For example, in a telephone-type telecommunication device, such an antenna is sensitive to interferences generated by motions of the hand or changes in the position of a user's body with respect to the antenna.

Antenna array calibration systems which modify the weighting coefficients of the antenna elements according to operating conditions during antenna calibration phases have already been provided.

Document US 2015/0115978 describes an antenna system where an array of electro-optical probes distributed in the radome of the antenna is used in calibration phases during which a distinct antenna, dedicated to the calibration, transmits. The coefficients associated with each antenna elements are set, during this calibration phase, according to the signals received by the different antenna elements and to signals retromodulated by the electro-optic probes.

Document US 2016/0036127 describes a reconfigurable antenna system, where a frequency reconfigurable antenna is associated with parasitic transmitting elements to set the directionality. These elements are associated with measurement components for the impedance matching and to other setting elements to adjust the radiation pattern. These measurements and settings however are not accompanied by a feedback for the readjustment of the loads which control the radiation pattern.

Known calibration systems are not adapted to a setting in real time of the radiation pattern, in particular when they require a transmitting element dedicated to the calibration.

Now, such an adjustment would be desirable particularly for antennas sensitive to close environmental interferences.

Further, the accuracy required for the adjustment of the amplitude and phase weighting coefficients of the different antenna elements due to the miniaturization of antennas makes indirect measurement solutions (impedance measurement) unsuitable.

SUMMARY

There is a need for a directional or super directional transmitting or receiving antenna adapted to being adjusted in real time.

There is a need for a reconfigurable antenna having its settings performed based on direct radiation measurements.

An embodiment overcomes all or part of the disadvantages of known reconfigurable antenna arrays.

An embodiment provides an antenna system comprising:

- a transmitting or receiving antenna element;
- an array of parasitic antenna elements individually associated with reconfigurable loads;
- one or a plurality of near-field antennas; and
- a circuit for setting the configuration of the array of parasitic antenna elements according to a radiation picked up by the antenna(s) in near field during a radio frequency transmission by the transmitting or receiving antenna element.

According to an embodiment, the circuit is configured to adjust impedance values of the reconfigurable loads according to a comparison, with reference data, of data representative of a radiation pattern of the system.

According to an embodiment, the reference data are representative of radiation patterns of the system in the presence of interferences.

According to an embodiment, the spacing between two antenna elements is smaller than one quarter of the wavelength of the central frequency of the bandwidth for which the array is intended.

According to an embodiment, the spacing between each near-field antenna and the closest antenna element is smaller than one tenth of the wavelength of the central frequency of the bandwidth for which the array is intended.

According to an embodiment, the system comprises exactly eight parasitic antenna elements equidistant from the transmitting or receiving antenna element and distributed every 45° around said element.

According to an embodiment, the transmitting or receiving antenna element and the array of parasitic antenna elements individually associated with the reconfigurable loads form part of a reconfigurable array of antenna elements.

An embodiment provides a method of configuration of the antenna system such as described, comprising the following steps:

a) identifying, from among a set of reference data, reference data which are the closest possible to data representative of a radiation pattern of the system; and

b) adjusting impedance values of the reconfigurable loads according to the identified reference data.

According to an embodiment, the reference data are representative of radiation patterns of the system in the presence of interferences.

According to an embodiment, at step b), the impedance values of the reconfigurable loads are adjusted to reference values associated with the reference data identified at step a).

According to an embodiment, the method further comprises, prior to step a), a step of recording of the reference data, said data being representative of radiation patterns of the system in the presence of interferences.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features and advantages of the present invention will be discussed in detail in the following non-limiting description of specific embodiments and implementation modes in connection with the accompanying drawing, in which:

FIG. **1** very schematically shows an embodiment of an antenna system;

FIG. **2** is a simplified perspective view of an embodiment of an arrangement of antennas in an antenna system of the type of that in FIG. **1**;

FIG. **3** very schematically shows in the form of blocks an example of functional architecture of an embodiment of an antenna system;

FIG. **4** very schematically shows in the form of blocks an implementation mode of a method of controlling parameters of the antenna elements of an antenna system;

FIG. **5** very schematically illustrates in a timing diagram the implementation of the control of the setting of a configurable antenna array;

FIG. **6** is a diagram illustrating an implementation mode of a training method; and

FIG. **7** is a diagram illustrating an implementation mode of a method of adjustment, in case of interference, of a field emitted by the antenna system of FIG. **3**.

DETAILED DESCRIPTION OF THE PRESENT EMBODIMENTS

Like features have been designated by like references in the various figures. In particular, the structural and/or functional elements common to the different embodiments and implementation modes may be designated with the same reference numerals and may have identical structural, dimensional, and material properties.

For clarity, only those steps and elements which are useful to the understanding of the described embodiments and implementation modes have been shown and will be detailed. In particular, the applications likely to implement the reconfigurable antenna arrays of the present disclosure are not detailed, the described embodiments and implementation modes being compatible with usual applications implementing reconfigurable antenna arrays.

Unless indicated otherwise, when reference is made to two elements connected together, this signifies a direct connection without any intermediate elements other than conductors, and when reference is made to two elements coupled together, this signifies that these two elements can be connected or they can be coupled via one or more other elements.

In the following description, when reference is made to terms qualifying absolute positions, such as terms “front”, “back”, “top”, “bottom”, “left”, “right”, etc., or relative positions, such as terms “above”, “under”, “upper”, “lower”, etc., or to terms qualifying directions, such as terms “horizontal”, “vertical”, etc., it is referred, unless specified otherwise, to the orientation of the drawings.

Unless specified otherwise, the terms “about”, “approximately”, “substantially”, and “in the order of” signify within 10%, preferably within 5%.

According to the described embodiments and implementation modes, it is provided to associate, with an array of antenna elements forming a reconfigurable directional antenna, elements for measuring the near-field radiation around the antenna array.

Reconfigurable super directional antennas can be distributed into three categories according to the nature of the system setting the directionality.

A first category concerns antennas with parasitic elements, in which a single one of the elements of the antenna array is active (that is, excited by the radio frequency signal to be transmitted, or useful signal, and/or coupled to a detector of the picked-up radiation), while the other elements of the array are loaded with impedances calculated to provide the active element with a desired radiation lobe. Typically, the secondary antenna elements are associated with loads having impedances determined according to the desired parasitic contributions on the main antenna element to concentrate the lobe of the main antenna in the desired direction.

A second category concerns antennas formed of a digital phased array, where each antenna element is coupled to a radio frequency transmit-receive chain. Individual amplitude and phase weighting coefficients are assigned to each antenna element in baseband (upstream of the amplifier and of the phase shifter of each antenna) so that the array has a desired directionality.

A third category concerns antennas formed of an analog phased array in which, like for the digital phased array, each antenna element transmits and/or receives a portion of the useful signal. However, in the case of analog phased array antennas, the power division and the amplitude and phase weightings assigned to each element are performed at the level of each antenna element, by a setting of the amplifier and of the phase shifter which are associated therewith.

The diameter of the antenna array is called “compact” if the radial spacing between the central element and the parasitic elements if smaller than 0.25λ, (lambda), where lambda represents the wavelength of the central frequency of the operating frequency band of the antenna array.

In the following description, an antenna array according to the first category, that is, an array where a single one of the antenna elements is active by being connected to the radio frequency transmitter and transmits or interprets the useful signal, will be taken as an example.

FIG. **1** very schematically shows an embodiment of a radio frequency transmission antenna system.

This system comprises an array **1** of antenna elements geometrically distributed in space. Taking the example of an array with a single active element, array **1** comprises a transmitting element or antenna **12** and a plurality of elements or antennas **14** distributed around element **12**. To form a super directional antenna, elements **12** and **14** are preferably arranged with respect to one another with distances between elements in the range from 0.5λ to 0.2λ, more preferably in the range from 0.25λ to 0.5λ, where λ (lambda) represents the wavelength of the central frequency of the operating frequency band of the antenna. In other words, the spacing between two antenna elements **12**, **14** of array **1** is smaller than half, preferably smaller than one quarter, of the wavelength λ of the central frequency of the bandwidth for which the array is intended.

According to a preferred embodiment, elements **14** are preferably substantially equidistant from element **12** and regularly distributed around element **12**. Elements **14** are for example located on the contour of a circle centered on element **12** and distributed at regular intervals on the contour of this circle. Array **1** comprises, preferably, eight elements

14 equidistant from element **12**. In this case, elements **14** are distributed every 45° around element **12**.

Transmitting element **12** is coupled, preferably via an impedance matching array **122** (impedance matching), to an electronic transmission circuit **16** (Tx). Usual elements (not shown) transmit to circuit **16** radio frequency signals to be transmitted according to the application. In the embodiments more particularly targeted by the present disclosure, the central frequency of the transmission frequency band is in the order of one gigahertz, preferably of a value in the range from 100 MHz to 7 GHz.

Each parasitic element **14** is associated with a configurable load **15**, preferably formed of switchable passive components to form impedances of variables values. In the example of FIG. **1**, each configurable load **15** is symbolized by three impedances **151**, **153** and **155**, coupled on the one hand to ground and, on the other hand, individually to a selector **157** of connection of one of the impedances **151**, **153**, and **155** to the associated parasitic antenna element **14**. Although three impedances **151**, **153**, and **155** have been shown for each configurable load **15** in FIG. **1**, it is obvious that configurable loads **15** may each comprise any number of impedances. Each selector **157** is individually controllable from an electronic digital central frequency and beam direction control circuit **18** (Control).

This is an example only and any usual configurable parasitic load structure may be used. A variant where the impedances **151**, **153**, and **155** of all or part of the configurable loads **15** are replaced with a single component having a variable impedance may in particular be provided. Selector **157** can then be omitted, the variable impedance component being in this case connected on the one hand to ground and, on the other hand, directly to the element **14** which is associated therewith.

The architecture described up to now in relation with FIG. **1** may be replaced with any antenna system with a reconfigurable antenna array, be it with parasitic elements or with a phased array of a plurality of active antenna elements.

According to the described embodiments, it is provided to associate, with reconfigurable array **1** of antenna elements, a device **3** comprising one or a plurality of near-field antennas **32** for measuring the radiation emitted by array **1**. Each near-field antenna **32** is coupled to an electronic circuit **34** (Assessment) for assessing the near-field radiation.

The results provided by the near-field radiation measurements are interpreted by circuit **34** to supply, to circuit **18**, setting parameters for the different loads **15**. A feedback loop is thus created in a way to control the radiation of the antenna array based on desired radiation parameters (radiation pattern). In a practical implementation, circuits **18** and **34** may be confounded and comprise a microcontroller for implementing a program or algorithm of interpretation of the measurements of the signals picked up by antennas **32** and of determination of the parameters of loads **15**.

By "near-field", there is meant a measurement of the electromagnetic field performed at a very short distance (in the order of from ten times to twenty times shorter) with respect to the wavelength λ corresponding to the central frequency of the bandwidth for which the array is intended. This distance for example corresponds to a spacing between the antenna elements **14** associated with configurable loads **15** to form the beam. Typically, it is considered that the responsive area around an antenna, that is, its sensitivity to the presence of interfering elements such as a hand, is in the order of $\lambda/2\pi$, that is, approximately $\lambda/6$. Thus, according to a preferred embodiment, each antenna **32** is arranged at a maximum distance of approximately $\lambda/10$ from the antenna element **12** or **14** which is closest thereto. In other words, the spacing between each near-field antenna and the antenna element **12** or **14** closest to array **1** is smaller than one tenth of the wavelength of the central frequency of the bandwidth for which the array is intended. Probes or antennas **32** may be arranged uniformly or non-uniformly around the antenna system, for example according to the type of radiation to be sampled.

As a specific example of embodiment, for an antenna system adapted to an operating frequency in the order of one gigahertz, the antenna elements **12** and **14** of antenna array **1** are spaced apart from one another by a maximum distance in the order of a few (less than 10) centimeters. Antennas **32** are respectively spaced apart from the antenna element **12** or **14** which is closest thereto by a distance of from approximately a few millimeters to a few centimeters.

According to the described embodiments, the respective distances between antennas **12**, **14**, and **32** are fixed. Thus, even if antennas **32** have an impact on the radiation pattern of the system, it is easy to take into account these parameters in the algorithm of analysis of the radiations picked up by near-field antennas **32**.

Preferably, in an antenna array with passive parasitic elements, the number of antennas **32** is smaller than or equal to the number of parasitic antenna elements **14** and each antenna **32** is associated with a parasitic antenna element **14**. In an array of antennas with active or reconfigurable antenna elements, the number of antennas **32** is preferably equal to the number of antenna elements **12** and **14** of array **1**.

FIG. **2** is a simplified perspective view of an embodiment of an arrangement of antennas in an antenna system of the type of that of FIG. **1**.

According to this embodiment, there are provided between four and twelve (twelve in the representation of FIG. **2**) antenna elements **14** distributed in a first group of six antenna elements **141** and a second group of six antenna elements **142**, arranged on two concentric circles around antenna element **12**. A number of antennas **32** which is a function of the number of antenna elements **141** or **142**, for example, from four to twelve (six in the representation of FIG. **2**) is also provided. Antennas **32** are distributed on a third concentric circle external to the circles of elements **141** and **142**.

FIG. **3** very schematically shows in the form of blocks an example of functional architecture of an embodiment of an antenna system.

This drawing illustrates the main interacting elements of the antenna system.

One can find:

- electronic transmission circuit **16** (Radio frequency transmitter) coupled to transmitting antenna **12** (Transmitting antenna);
- an array **1415** (Reconfigurable parasitic array) of reconfigurable parasitic elements (elements **14** and loads **15**, FIG. **1**);
- an array of antennas or near-field probes **32** (Probes); and
- electronic circuits **1834** (Processing unit) fulfilling, among others, the functions of interpretation of the measurements of the signals picked up by antennas **32** and of determination of the parameters of the loads of array **1415**.

In the shown example, the system further comprises a memory **20** (Memory). Memory **20** for example comprises at least one non-volatile storage memory region and at least another volatile storage memory region.

The system may also comprise one or a plurality of other elements. These elements are symbolized, in FIG. **2**, by a functional block **22** (FCT).

As illustrated in FIG. **3**, antenna **12**, the elements **14** of parasitic array **1415**, and probes **32** are in an electromagnetic coupling relation (EM coupling).

FIG. **4** very schematically shows in the form of blocks an implementation mode of a method of controlling parameters of the antenna elements **14** of array **1** on set point values (REF) for a given radiation pattern of array **1**.

When the antenna system enters a transmission mode (block **52**, Transmission), circuit **16** is activated and generates a radio frequency signal (block **54**, Signal generation). This results in a far-field transmission (block **56**, Far field) by the array according to a radiation pattern conditioned by the parameters of parasitic antennas **14**. By far field, there is meant at a distance from the system greater than some ten meters.

In parallel, the electromagnetic field emitted in the immediate vicinity of array **1** is picked up (block **72**, Near-field detection) by antennas **32**, and the measured signals are sent by the latter to circuit **34**. Circuit **34** then performs an analysis (block **74**, Analysis) of these signals with respect to reference or set point values (REF). If the signals measured by antennas **32** differ from the reference values, circuit **34** orders (block **76**, Parameters), via circuit **18**, the reconfiguration of the load impedances **151**, **153**, and **155** connected to antenna elements **14**.

The modification of the parameters of parasitic antennas **14**, or of their immediate context, is immediate and thus modifies the radiation pattern of system **1**. The steps of detection **72**, or analysis **74**, and of setting **76** are preferably carried out in a loop (looping back of the output of block **76** onto the input of block **72**) as long as array **1** is transmitting. Thus, it is possible to provide, at the level of the algorithm of analysis and determination of the control parameters of configurable loads **151**, **153**, and **155**, results in the form of progressive increases or decreases of such or such impedance of each configurable load.

FIG. **5** very schematically illustrates in a timing diagram the implementation of the control of the setting of a reconfigurable antenna array.

This drawing shows, in simplified fashion, an example of interference of a main emission lobe with respect to a set point or reference level REF (Reference directionality (REF)). Assuming the arrival of an interference p (Interference (p)), for example, the motion of a hand, in the system environment, this interference p translates as a deformation of the radiation pattern of array **1**, or of the direction of the lobe, or also of the directionality (Directionality in the direction of use (dBi)). The implementation of the steps of measurement (Detection) and analysis of the radiation picked up by near-field antennas **32** corrects (Converging loop) this drift by modifying the parameters of the reconfigurable array (loads **151**, **153**, and **155**) of antennas **1** to recover reference direction REF.

The number of points of measurement of the near-field radiation, and thus of antennas **32**, depends on the application and, particularly, on the desired resolution or fineness in the number of interference situations to be characterized.

An advantage of the described system lies in the fact that it allows a real-time control of the transmitting antenna array. Indeed, the measurements of the signals picked up by the antennas **32** of device **3** as well as the analysis and the interpretation performed by circuit **34** require no specific intervention of the transmitting system. It is sufficient for the latter to be transmitting.

Another advantage lies in the fact that a real-time control also enables to compensate for possible variations of the radiation pattern due to variations of operating conditions such as temperature.

As compared with a system with optical probes, an advantage of the described system is that it requires no transmission by a specific antenna.

However, although the described system has a particularly high performance to set a transmitting antenna array, it may as a variant be implemented for a receiving antenna array. In this case, an operating phase during which the system switches to the transmission of a signal by antenna array **1** is periodically provided. Preferably, to avoid disturbing the reception, it is provided for such a transmission and setting phase to be performed with a duty cycle (duration of the transmission phase with respect to its periodicity) smaller than 10%, preferably smaller than 1%, or for example for 1 ms every 100 ms.

An antenna system such as described is particularly advantageous in applications such as antenna array diagnosis applications, RFID-type radio frequency communication applications using multiple-standard miniature readers, applications of electromagnetic compatibility measurement equipment, or antennas for test chambers, miniature directional radars, compact super directional antennas, etc.

FIG. **6** is a diagram illustrating an implementation mode of a training method. As an example, a non-volatile storage memory region of memory **20** (FIG. **3**) stores program code instructions which, when they are executed by processing unit **1834**, enable the implementation of this method.

At a first step (block **81**, Control the antenna to obtain a radiation pattern Di), antenna **12** is controlled (FIG. **1**) so that array **1** emits an electromagnetic field having a radiation pattern Di. Diagram Di for example corresponds to a situation where the field emission by array **1** is submitted to no interference.

At a second step (block **82**, Cause an interference of the field emitted by the antenna), subsequent to first step **81**, an interference of the electromagnetic field radiated by array **1** is intentionally caused. This interference is for example caused by placing an object, a hand, etc. in the vicinity, for example, at a distance of a few centimeters or tens of centimeters, from array **1**.

At a third step (block **83**, Assess a radiation pattern Dp of the antenna submitted to the interference), subsequent to second step **82**, a diagram Dp of the radiation emitted by array **1** is evaluated. Diagram Dp, resulting from a modification of diagram Di caused by the introduction of the interference at the previous step, is for example assessed as previously discussed in relation with step **74** of the method of FIG. **4**. Data representative of diagram Dp are particularly obtained due to the antennas **32** of system **3**. These data are for example temporarily stored in a volatile storage memory region of memory **20**.

At a fourth step (block **84**, Adjust the impedance values of the parasitic loads to restore diagram Di), subsequent to third step **83**, one controls, via circuit **18**, the reconfiguration of the load impedances **151**, **153**, and **155** connected to antenna elements **14** to restore, or to approach as much as possible, diagram Di. In other words, it is desired to reconfigure array **1** so that it emits, despite the presence of the interference, an electromagnetic field having a radiation pattern as close as possible to the diagram Di radiated by array **1** in the absence of interference.

At a fifth step (block **85**, Record the impedance values enabling, based on diagram Dp, to restore diagram Di), subsequent to fourth step **84**, the parameters enabling, when radiation pattern Dp is detected by the antennas **32** or device **3**, to restore radiation pattern Di, are stored. The storage of the parameters is for example performed in a non-volatile storage memory region of memory **20**.

At a sixth step (block **86**, Stop the interference and apply the impedance values enabling to obtain diagram Di in the absence of interference), subsequent to fifth step **85**, the interference is removed (for example, the object, the hand, etc. are taken away from array **1**) and the parameters enabling to obtain radiation pattern Di in the absence of interference are applied. For this purpose, parameters identical to those of first step **81** are for example applied.

The steps **81** to **86** of the method are for example repeated by varying the type of interference, the position of the interfering element (object, hand, etc.) with respect to array **1**, the radiation pattern Di which is desired to be obtained, etc. Generally, it is desired to apply interferences representative of situations likely to occur during the use of array **1**. There is thus formed, in memory **20** of the array, a lookup table between, on the one hand, reference data representative of the radiation pattern of array **1** when it is submitted to different interferences and, on the other hand, parameters, or reference impedance values, enabling to restore or to approach diagram Di in the absence of interference.

As a variant, it may be provided for all or part of the data representative of the radiation patterns and of the parameters stored in memory **20** of the system to be obtained by simulation, for example, by simulating an impact of different interferences on the radiation pattern of array **1** and then by determining, by calculation, correction parameters enabling to come down to diagram Di for each of these interferences.

FIG. **7** is a diagram illustrating an implementation mode of a method of adjustment, in case of interference, of a field emitted by the antenna system of FIG. **3**. As an example, a non-volatile storage memory region of memory **20** (FIG. **3**) stores program code instructions which, when they are executed by processing unit **1834**, allow the implementation of this method.

At a first step (block **91**, Control the antenna to obtain radiation pattern Di), antenna **12** is controlled (FIG. **1**) so that array **1** emits an electromagnetic field having the radiation pattern Di previously described in relation with FIG. **6**. Diagram Di for example corresponds to a situation where the field emission, by array **1**, is submitted to no interference.

At a second step (block **92**, In case of interference, assess the radiation pattern Dp of the antenna submitted to the interference), subsequent to first step **91**, a case where array **1** is submitted to an interference is considered. Array **1** then emits an electromagnetic field having radiation pattern Dp. For simplification, the case where the interference present at step **92** is similar to the interference intentionally applied at step **82** of the method of FIG. **6**, and where the diagram Dp of step **92** corresponds to the diagram Dp of step **83** of FIG. **6**, is considered. However, the following steps are easily adaptable by those skilled in the art to a case where the interference is different from that of step **82** and where diagram Dp is different from that of step **83**.

At a third step (block **93**, Identify a radiation pattern Dk approaching diagram Dp), subsequent to second step **92**, a radiation pattern Dk identical or as close as possible to diagram Dp is searched for and identified. As an example, processing unit **1834** scans the content of memory **20** for data representative of diagram Dk approaching at best the data representative of diagram Dp. Diagram Dk for example forms part of a set of radiation patterns previously recorded into memory **20** of the system, for example, at the implementation of the method of FIG. **6** for different interferences, having impedance values of the loads **15** of array **1** corresponding thereto.

At a fourth step (block **94**, Apply the impedance values enabling, based on diagram Dk, to restore diagram Di), subsequent to third step **93**, the parameters (impedance values) enabling, when radiation pattern Dk is detected by system **3**, to restore diagram Di or to approach at best diagram Di are applied. These parameters associated with diagram Dk for example have been previously stored in memory **20** of the system at the implementation of the method of FIG. **6** in the case of an interference resulting in diagram Dk.

At a fifth step (block **95**, Once the interference is over, apply the impedance values enabling to obtain diagram Di in the absence of interference), subsequent to fourth step **94**, it is assumed that the interference has disappeared (for example, the object, the hand, etc. has moved away from array **1**). The parameters enabling to obtain radiation pattern Di in the absence of interference are then applied. For this purpose, parameters identical to those of first step **91** are for example applied.

An advantage of the methods previously-described in relation with FIGS. **6** and **7** lies in the fact that they allow a decrease of the adaptation time of array **1** in case of an interference. This results in a better capacity of transmission and/or reception by array **1** despite the presence of interferences.

Various embodiments and variants have been described. Those skilled in the art will understand that certain features of these various embodiments and variants may be combined, and other variants will occur to those skilled in the art. In particular, the system dimensions and the spacings between antennas depend on the application and particularly on the frequency of the system. Similarly, the number of antenna elements **12**, **14** of array **1** and the number of antennas **32** of device **3** depend on the application.

Further, although this has not been described in detail, the adaptation of the described embodiments and implementation modes to the variant where the impedances **151**, **153**, and **155** of all or part of configurable loads **15** are replaced with a single component having a variable impedance is within the abilities of those skilled in the art.

Finally, the practical implementation of the described embodiments and variants is within the abilities of those skilled in the art based on the functional indications given hereabove. In particular, the selection of the arrangement of the antenna elements of array **1** and of the antennas **32** of device **3** depends on the application. Those skilled in the art are in particular capable of arranging the antennas **32** of device **3** so as to assess the field emitted in directions where it is desired to radiate with a maximum intensity and/or in directions where it is desired to radiate with a minimum, or even substantially zero, intensity.

Further, the adaptation of the described system to an antenna system where the array of antenna elements comprises a plurality of antennas transmitting with amplitude and phase weighting coefficients which are a function of the desired radiation pattern is within the abilities of those skilled in the art.

What is claimed is:

1. Antenna system comprising:

a transmitting or receiving antenna element;

an array of parasitic antenna elements individually associated with reconfigurable loads;

a plurality of near-field antennas; and

a circuit for setting the configuration of the array of parasitic antenna elements according to a radiation picked up by the near-field antennas during a radio frequency transmission by the transmitting or receiving antenna element,

wherein the circuit is configured to adjust impedance values of the reconfigurable loads according to a comparison, with reference data representative of radiation patterns of the system in the presence of interferences, of data representative of a radiation pattern of the system,

and wherein each near-field antenna is coupled to an electronic circuit for assessing near-field radiation.

2. The system according to claim **1**, wherein the spacing between two antenna elements selected from the transmitting or receiving antenna element, on the one hand, and the parasitic antenna elements, on the other hand, is smaller than one quarter of the wavelength of the central frequency of the bandwidth for which the array is intended.

3. The system according to claim **1**, wherein the spacing between each near-field antenna and a closest antenna element is smaller than one tenth of the wavelength of the central frequency of the bandwidth for which the array is intended, wherein the closest antenna element is selected from the transmitting and receiving antenna element and the parasitic antenna elements.

4. The system according to claim **1**, comprising exactly eight parasitic antenna elements equidistant from the transmitting or receiving antenna element and distributed every 45° around said element.

5. The system according to claim **1**, wherein the transmitting or receiving antenna element and the array of parasitic antenna elements individually associated with the reconfigurable loads form part of a reconfigurable array of antenna elements.

6. A method of configuration of the antenna system of claim **1**, comprising the following steps:

a) identifying, from among a set of reference data, the reference data representative of the radiation patterns of the system in the presence of interferences which are the closest possible to the data representative of the radiation pattern of the system; and

b) adjusting the impedance values of the reconfigurable loads according to the identified reference data.

7. The method according to claim **6**, wherein, at step b), the impedance values of the reconfigurable loads are adjusted to reference values associated with the reference data identified at step a).

8. The method according to claim **6**, further comprising, prior to step a), a step of recording of the reference data in a memory.

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